OPERATING AND SERVICE MANUAL

352A TRANSDUCER INDICATOR

BLH ELECTRONICS
42 FOURTH AVENUE, WALTHAM, MA 02254
TEL: (617) 890-6700 • TWX: 710-324-0683 • TELEX: 92-3413 • CABLE 'BALIMA'

TM 352A-1

WARRANTY AND ASSISTANCE

BLH warrants the product(s) covered hereby to be free from defects in material and workmanship. BLH's liability under this guarantee shall be limited to repairing or furnishing parts to replace, f.o.b. point of manufacture, any parts which, within one (1) year from date of shipment of said product(s) from BLH's plant, fail because of defective workmanship or material performed or furnished by BLH. As a condition hereof, such defects must be brought to BLH's attention for verification when first discovered, and the material or parts alleged to be defective shall be returned to BLH if requested. BLH shall not be liable for transportation or installation charges, for expenses of Buyer for repairs or replacements or for damages from delay or loss of use or for other indirect or consequential damages of any kind. BLH may use improved designs of the parts to be replaced. This guarantee shall not apply to any material which shall have been repaired or altered outside of BLH's plant in any way so as, in BLH's judgment, to affect its strength, performance or reliability, or to any defect due in any part to misuse, negligence, accident or any cause other than normal and reasonable use, nor shall it apply beyond their normal span of life to any materials whose normal span of life is shorter than the applicable period stated herein. In consideration of the foregoing guarantees, all implied warranties are waived by Buyer. BLH does not guarantee quality of material or parts specified or furnished by Buyer, or by other parties designated by Buyer, if not manufactured by BLH. If any modifications or repairs are made to this equipment without prior factory approval, the above warranty can become null and void.

For any assistance contact your nearest BLH Electronics Sales and Service Office.

PATENT INFORMATION

BLH Equipment is manufactured under one or more of the following patents:

2,771,579	*3,083,689*	*3,405,359*	*3,554,503*
2,815,480	*3,085,847*	*3,434,343*	*3,600,670*
2,846,645	*3,334,352*	*3,434,453*	*3,617,878*
2,932,776	*3,350,927*	*3,438,056*	*3,667,041*

Patented in Canada 1955, 1958, 1960, 1966, 1967, 1968, 1970.

BLH ELECTRONICS
42 FOURTH AVENUE, WALTHAM, MA 02254
TEL: (617) 890-6700 • TWX: 710-324-0653 • TELEX: 92-3413 • CABLE 'BALIMA'

OPERATING AND SERVICE MANUAL

352A TRANSDUCER INDICATOR

PRINTED IN U.S.A.

BLH®

TABLE OF CONTENTS

Section			Page
I	GENERAL INFORMATION		
	1-1.	Introduction	1-1
	1-3.	Description	1-1
	1-6.	Controls	1-1
	1-8.	Specifications	1-1
II	INSTALLATION		
	2-1.	Inspection	2-1
	2-2.	Mechanical Inspection	2-1
	2-4.	Electrical Check	2-1
	2-6.	Installation	2-1
	2-8.	Electrical Connections	2-1
	2-9.	Power Requirements	2-1
	2-11.	Transducer Connections	2-1
	2-13.	Control Data	2-1
III	OPERATION		
	3-1.	Operation	3-1
	3-2.	Battery Check	3-1
	3-4.	Testing Transducers	3-1
IV	PRINCIPLES OF OPERATION		
	4-1.	General	4-1
	4-4.	Indicator Measuring Circuit	4-1
	4-6.	Power Source	4-1
	4-8.	Inverter	4-2
	4-10.	Amplifier	4-2
V	MAINTENANCE		
	5-1.	Maintenance	5-1
	5-2.	General	5-1
	5-4.	Battery Replacement	5-1
	5-6.	Troubleshooting	5-1
	5-7.	Preliminary	5-1
	5-9.	Meter Sensitivity Test	5-1
	5-11.	Transducer Excitation Test	5-1
	5-13.	Troubleshooting the Inverter	5-2
	5-15.	Troubleshooting the Measuring Circuit	5-2
	5-20.	Calibration	5-3
VI	REPLACEABLE PARTS		
	6-1.	Introduction	6-1
	6-3	Ordering Information	6-1

LIST OF ILLUSTRATIONS

Figure		Page
2-1.	Model 352A Typical Connections	2-2
2-2.	Model 352A Control Data	2-3
4-1.	Model 352A Block Diagram	4-1
4-2.	Null-Balance Functional Diagram, Model 352A	4-2
5-1.	Model 352A Schematic	5-1
5-2.	DC - AC Inverter Schematic	5-2
5-3.	Measuring Circuit Schematic	5-2
5-4.	Amplifier Schematic	5-3
6-1.	Model 352A Parts Locations	6-2

LIST OF TABLES

Table		Page
1-1.	Specifications	1-2
6-1.	Replaceable Parts	6-2

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This manual contains the basic installation, calibration, operation, and maintenance instructions for the BLH Model 352A Transducer Indicator.

1-3. DESCRIPTION

1-4. The BLH Model 352A Transducer Indicator, Figure 1-1, is a manually null-balanced, transistorized, portable, percent reading instrument. It may be used as a troubleshooting device to check the output and balance of transducers (either in the field or laboratory). These two checks will quickly determine if a transducer is defective. The 352A simplifies the installation of strain gage transducers by confirming their correct operation prior to completing the cable connections. It also helps to determine that all transducers in a multi-transducer system are equally loaded. The 352A is an inexpensive transducer readout for those systems which require periodic inspection.

1-5. A two-position mV/V range selector on the front panel makes the 352A universal in application. Although primarily for use with BLH transducers, the 352A may be used with any other full bridge resistance transducer within the range of 120 ohms to 350 ohms. The Indicator is completely solid-state and is designed for trouble-free service under difficult field conditions.

1-6. CONTROLS

1-7. All controls on the Model 352A Transducer Indicator are front panel mounted. The controls are illustrated and described in Section II, Figure 2-2.

1-8. SPECIFICATIONS

1-9. Specifications for the Model 352A are listed in Table 1-1.

Figure 1-1. Model 352A Transducer Indicator

Table 1-1. Specifications.

ACCURACY:	±0.5%
READOUT:	0-100%, 10-turn Counter.
LINEARITY:	±0.25%
REPEATABILITY:	0.1%
READABILITY:	0.05%
BRIDGE RESISTANCE:	120 or 350 ohms.
RANGE:	2mV/V and 3mV/V
POWER:	Four Internal 1-1/2 volt Batteries.
EXCITATION:	3V, 1Khz
CONTROLS:	Power Control, Battery Check Switch, Range Selector, % Output Balancing Control.
CONNECTIONS:	Binding Posts.
DIMENSIONS:	133.4mm x 215.9mm x 107.0mm (HWD) (5-1/4" x 8-1/2" x 4-1/4" (HWD))

SECTION II
INSTALLATION

2-1. INITIAL INSPECTION

2-2. Mechanical Inspection

2-3. If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the unit for external damage such as broken case. If damage is found, notify the carrier and the nearest BLH Sales/Service Office. Retain the packing material for possible future use.

2-4. Electrical Check

2-5. Check the electrical performance of the equipment as soon as possible after receipt. The normal operation process should provide a valid indication of satisfactory performance.

2-6. INSTALLATION

2-7. The BLH Model 352A is a portable unit and requires no special installation procedures. The unit will operate safisfactorily between 0 and 120°F in most environments. It should be stored in an area free from unusual temperature extremes, high humidity and vibration.

2-8. ELECTRICAL CONNECTIONS

2-9. Power Requirements

2-10. The Model 352A operates with four 1-1/2V "C" cell batteries.

2-11. Transducer Connections

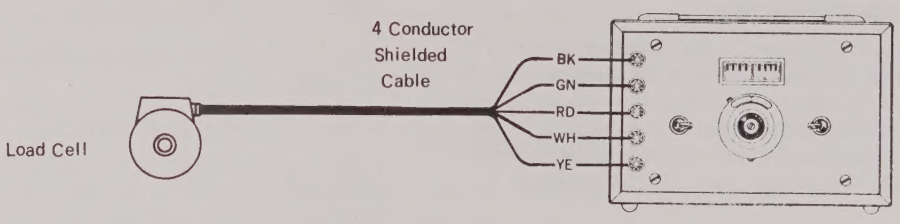
2-12. Connections to the Model 352A are made to the binding posts at the left side of the front panel. The binding posts are color-coded to coincide with the colors of the transducer cable loads. When testing compression transducers, connect the cable leads to the binding posts color-for-color. Reverse the RED and WHITE signal leads when testing universal transducers being loaded in a tension direction. Typical connections are shown in Figure 2-1.

2-13. CONTROL DATA

2-14. Operator controls are illustrated and described in Figure 2-2.

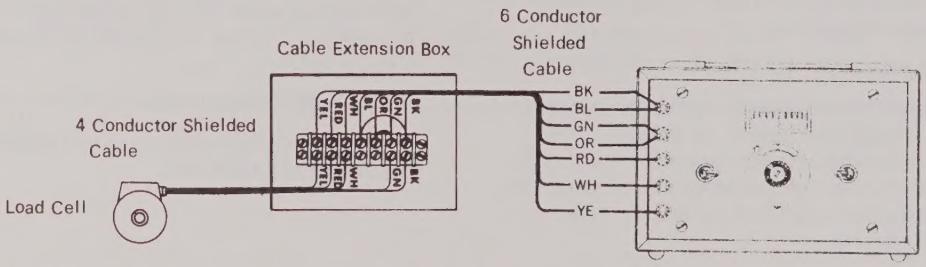
SINGLE TRANSDUCER:

CHECKS TRANSDUCER PRIOR TO COMPLETING CABLE CONNECTIONS.

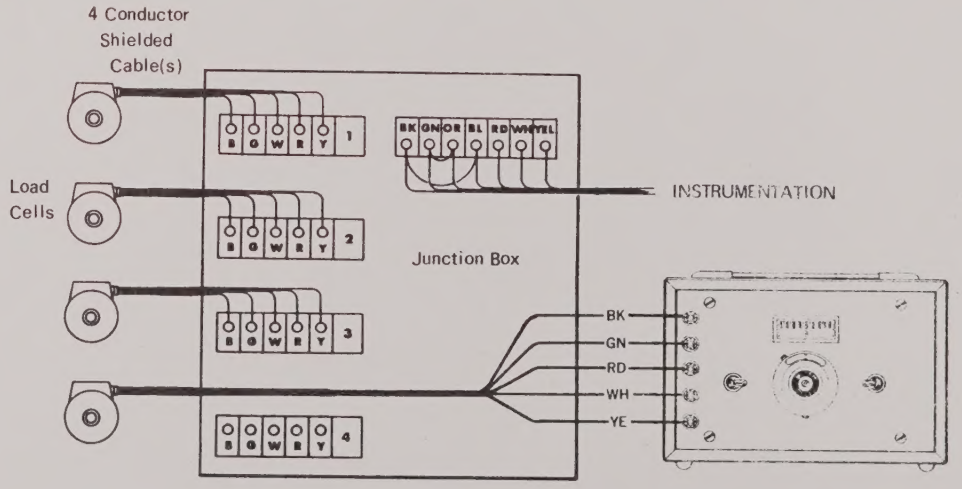


TRANSDUCER WITH EXTENSION BOX:

CHECKS TRANSDUCER, CABLES, EXTENSION BOX.

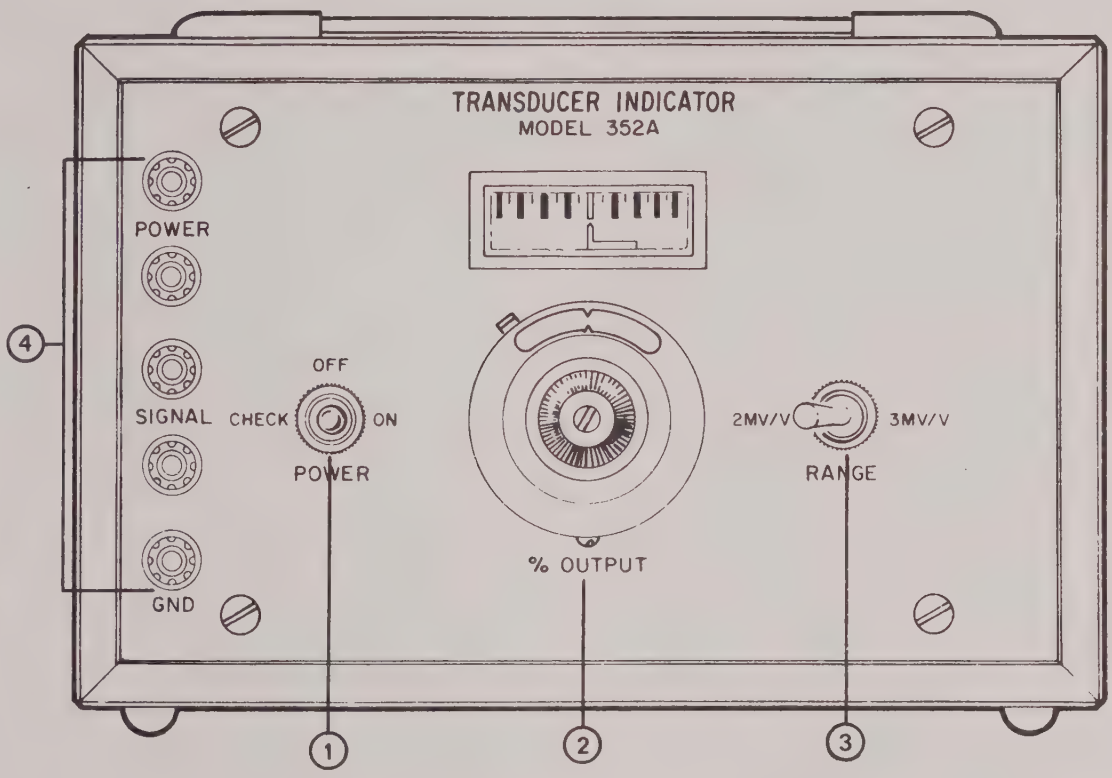


MULTIPLE TRANSDUCER SYSTEMS:



NOTE: 352A can be connected to each cell in turn to check individual transducer and load.

Figure 2-1. Model 352A Typical Connections.



1. POWER - 3 position (ON/OFF/CHECK) toggle switch controls internal power supply. CHECK position provides indication of battery condition.

2. % OUTPUT - Duo-dial control to balance transducer output against the measuring circuit output. Meter nulls when balance occurs and % of transducer output is read directly from the dial.

3. Two position (2mV/V, 3mV/V), toggle switch. Selects measuring circuit excitation equal to the mV/V output of transducer in use.

4. Binding Posts - Color-coded binding posts for interconnecting with transducer.

Figure 2-2. Model 352A Control Data

SECTION III
OPERATION

3-1. OPERATION

3-2. Battery Check

3-3. Before connecting the transducer to the 352A indicator, place the POWER switch to the CHECK position. The null meter needle should deflect to the right and beyond the red area. If the meter needle remains in the red area, the battery must be replaced. Refer to the maintenance section for the battery replacement procedure.

3-4. Testing Transducers

3-5. Check suspected transducers with the Model 352A as follows, referring to Figure 2-1 for connection details;

a. Connect the cell cable, color for color, to the binding posts of the 352A.

b. Set the RANGE switch to 2mV/V or 3mV/V position, depending upon the rated full load output of the cell.

c. Set the POWER switch to CHECK. The meter needle should swing beyond the red area.

d. Set the POWER switch to ON and allow one minute warm-up.

e. Test transducer with zero tare weight by applying a known load to the transducer.

f. Rotate the % OUTPUT dial until the meter needle is in the center of the null position. The reading is the percent of the transducer rated capacity and should correspond to the weight applied. Each dial division represents 0.1%. If the cell is being used in tension, the red and white wires will have to be reversed.

g. Test transducers with tare weight by rotating the % OUTPUT dial until the needle nulls. Record the reading, then apply a known weight to the transducer (s).

h. Rotate the % OUTPUT dial to again null the needle. The difference in readings, expressed in percent of the transducer rated capacity, should agree with the applied weight. If the cell is part of a multi-cell system supporting a tank or other vessel and assuming equal load distribution, the cell being tested will be monitoring a proportionate amount of the applied weight.

i. Check each transducer in multi-cell systems by repeating the above procedures. The sum of the individual readings is the combined tare weight and load.

NOTE

On multiple transducer systems, the transducers should be spaced and shimmed so that the cells carry equal loads and provide outputs within 10% of each other.

SECTION IV
PRINCIPLES OF OPERATION

4-1. GENERAL

4-2. The transducer connected to the Model 352A produces an output voltage proportional to the load applied. The Indicator measures the voltage and translates this voltage into an indication in percent of transducer output. Refer to Block Diagram in Figure 4-1.

4-3. The 352A ircuit includes a 5-volt dc-ac inverter, an amplifier, a demodulator, a null meter, and a measuring circuit. The inverter supplies power to the measuring circuit, the transducer, and the reference winding of the demodulator. The difference between the transducer output voltage and the measuring circuit voltage is fed to the amplifier. The amplifier output is fed to the demodulator, producing a dc voltage. This voltage is dependent upon the magnitude and polarity of the difference between the transducer and measuring circuit voltages. The duo-dial, attached to the slide-wire, is rotated manually to bring the meter to the null point. The resulting indication on the duo-dial is the magnitude of the transducer output. The dial has a scale of 0 - 100 percent in steps of 0.1 percent.

4-4. INDICATOR MEASURING CIRCUIT

4-5. The Transducer Indicator uses a measuring circuit based upon the null balance principle. See Figure 4-2 for the functional diagram. The circuit consists of a resistance balancing network and an electronic amplifier. The bridge of the transducer sensing element is electrically connected to this measuring circuit. The amplifier operates from the measuring circuit to drive the meter to a position determined by a slide-wire coupled to the % OUTPUT control. Any difference in voltage output between the instrument and the transducer is amplified and sent to the null meter. Operating the % OUTPUT control moves the brush on the slide-wire until the measuring circuit output equals the transducer output; at this point, the meter nulls. Since the null meter operates in conjunction with the % OUTPUT control, its final position will be related to the position of the slide-wire brush, and, therefore, to the output of the transducer.

4-6. POWER SOURCE

4-7. Power to the inverter and amplifier is supplied by four 1-1/2 volt "C" cell batteries connected in series. The battery power can be checked periodically by positioning the power switch to the CHECK position. In this position, a portion of the battery voltage excites the null meter. Satisfactory battery voltage is indicated by the meter needle deflecting to the right and beyond the red area. When battery voltage is low, the meter needle will fall in the red area indicating the need for replacing the batteries.

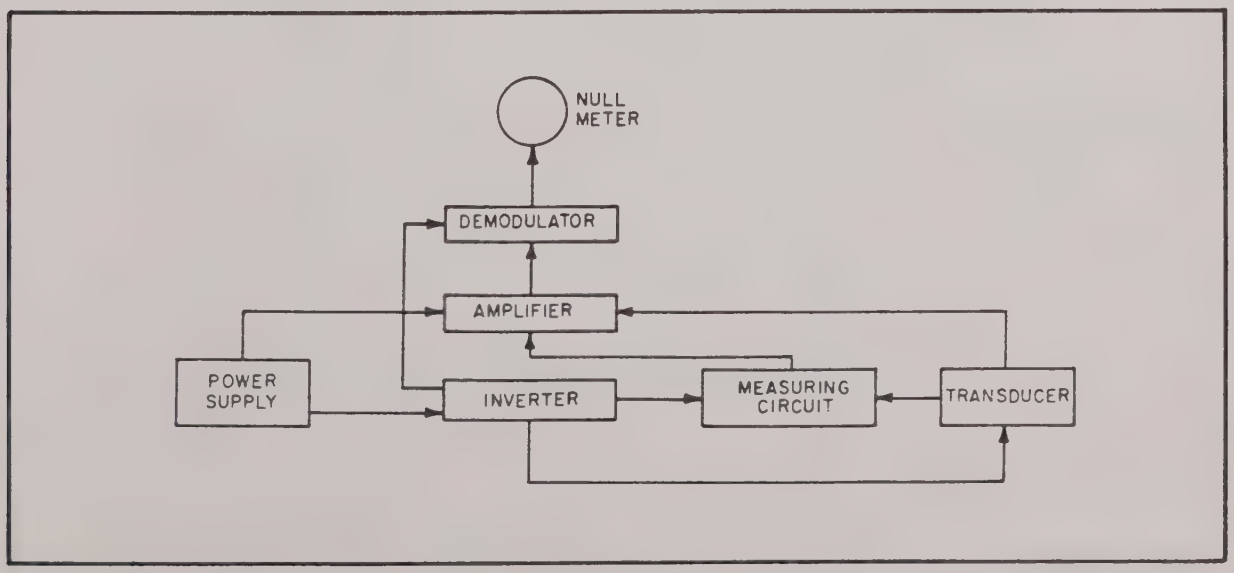


Figure 4-1. Model 352A Block Diagram

4-8. INVERTER

4-9. The DC-AC Inverter, energized by the 6-volt battery power, provides an ac output in the form of a square wave with a frequency of approximately 1000 Hz. Four separate voltages are obtained from the output transformer, 1, 1.2, 1.8, and 3V. The 1-volt winding is the reference supply for the demodulator on the amplifier board; the 1.2 and 1.8 volt windings supply the measuring circuit voltage and the 3-volt winding excites the transducer.

4-10. AMPLIFIER

4-11. The amplifier input provides a single ended signal to the phase splitter Q1. This signal is amplified through two differential R-C coupled amplifier stages, Q2/Q3, and Q4/Q5. R10, balancing potentiometer, balances the output of Q2 and Q3. The output of Q4 and Q5 is applied to the primary of Transformer T1. Refer to schematic, Figure 5-4.

4-12. The amplified signal passes from the amplifier section to the demodulator section on the amplifier circuit board. The demodulator produces a dc voltage to deflect the null meter pointer. The polarity and magnitude of this voltage are dependent upon the phase and magnitude of the difference between the transducer and the measuring circuit voltages.

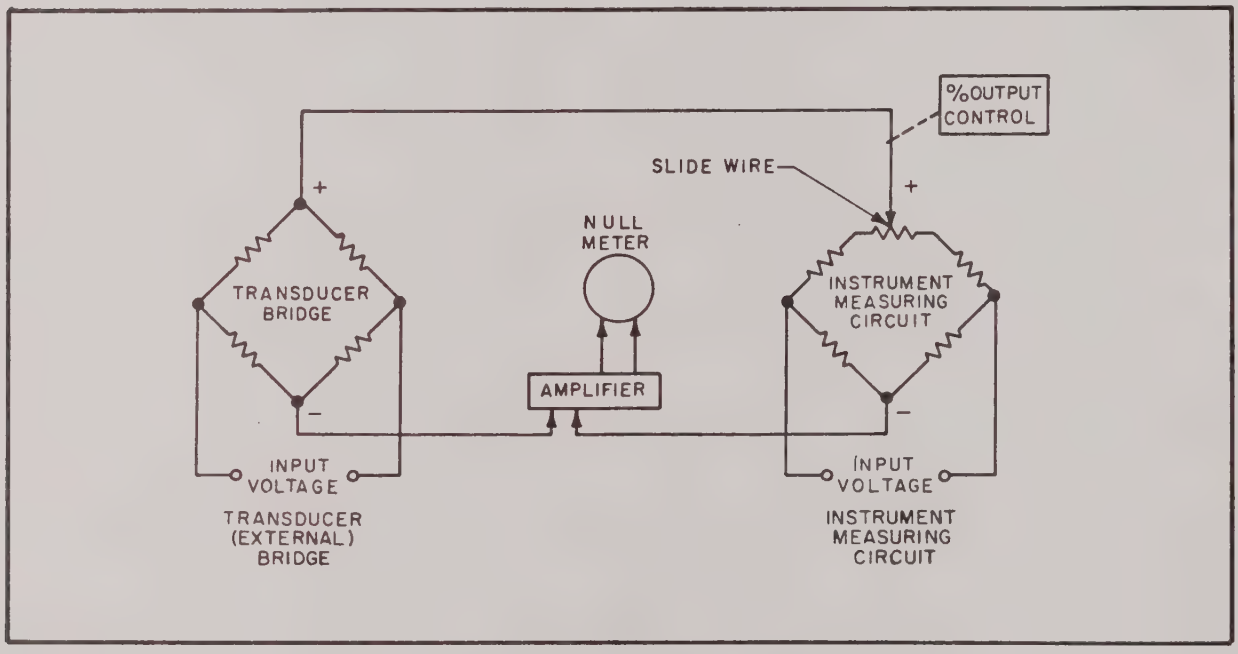


Figure 4-2. Null-Balance, Functional Diagram, Model 352A.

SECTION V
MAINTENANCE

5-1. MAINTENANCE

5-2. General

5-3. Periodic inspection or maintenance is unnecessary except for checking and replacing the batteries required by service. The components are operated well within the peak ratings and should provide trouble-free operation.

5-4. Battery Replacement

5-5. Loosen the four screws on the front panel and pull the Indicator out of the case. The batteries are located in the clips attached to the bottom of the chassis. Slide batteries out of the clips and replace with new "C" cells. Observe polarity. Return Indicator to the case and secure with four screws.

5-6. TROUBLESHOOTING

5-7. Preliminary

5-8. Before troubleshooting the Indicator, perform the following checks to determine if the problem is in the 352A or the external circuit. Check the battery voltage and check the calibration as described under OPERATION. Refer to Figure 5-1 for schematic diagram.

5-9. Meter Sensitivity Test

5-10. This check will indicate whether or not the amplifier and measuring circuit are operating properly.

a. Short the RED and WHITE binding posts with a clip lead.

b. The null meter needle should be at zero (center of meter scale).

c. Rotate the % OUTPUT control until the meter needle is deflected full scale. The dial should read approximately 0.5 to 1 percent. If not, proceed to the troubleshooting paragraphs.

5-11. Transducer Excitation Test

5-12. Use a multimeter and check the voltage across the BLACK and GREEN binding posts. The reading should be approximately 3V rms. If not, proceed with the internal troubleshooting.

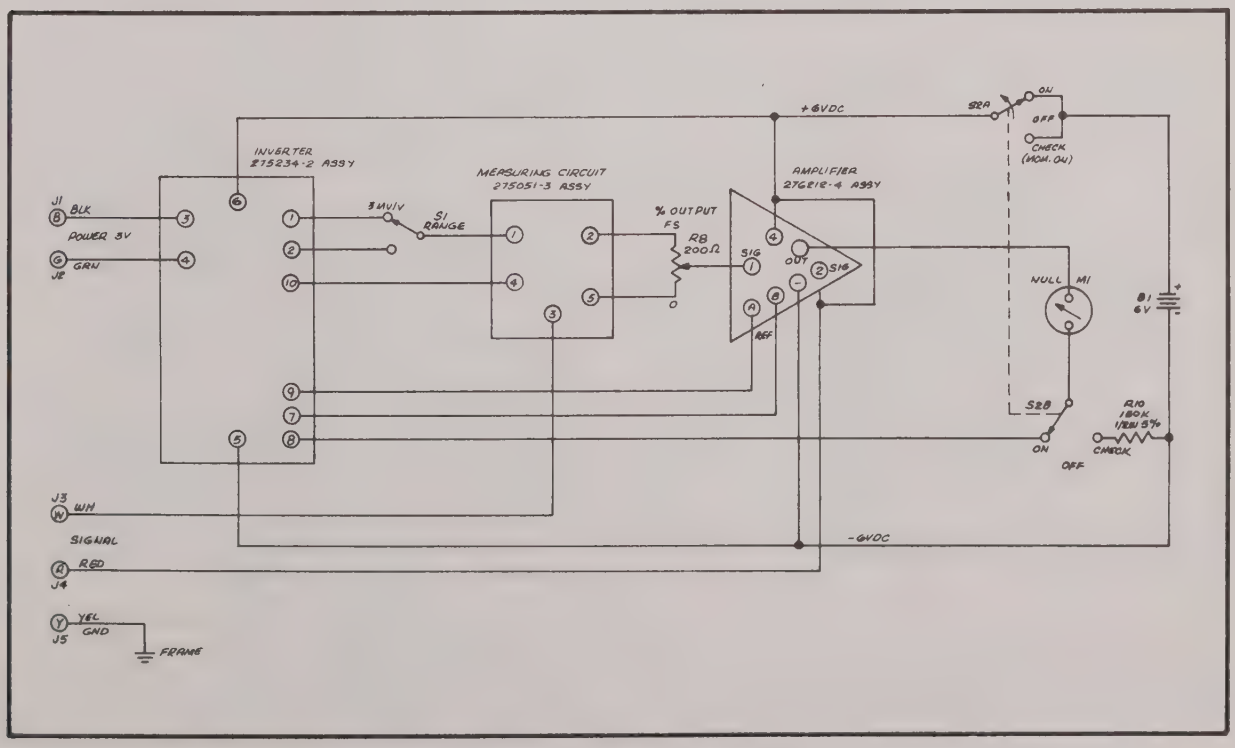


Figure 5-1. Model 352A Schematic

5-13. Troubleshooting the Inverter (Figure 5-2)

5-14. Remove the indicator from the Test Set. The inverter can be checked without disconnecting it from the circuit or removing it from the instrument as follows:

a. Add a 120-ohm, 1/2 watt, ±10%, resistor across the BLACK and GREEN binding posts.

b. Connect an oscilloscope, single-ended across the BLACK and GREEN binding posts. The wave shape across the 120-ohm resistor should be a 8.5V p-p square wave with a frequency of 1000 Hz, ±10%.

c. Check the measuring circuit supply voltage by placing the oscilloscope leads across pins 1 and 4 of the measuring circuit board. With the RANGE switch in the 2mV/V position, the p-p square wave should be 4.3V. With the RANGE switch in the 3mV/V position, the p-p square wave should be 5.04V.

d. Check the reference supply to the demodulator across pins 7 and 9 of the inverter or across pins A and B on the amplifier board. The reading should be 2.8 volts p-p.

e. If the unit fails any of the above, it must be replaced. When the inverter is replaced, the unit should be recalibrated.

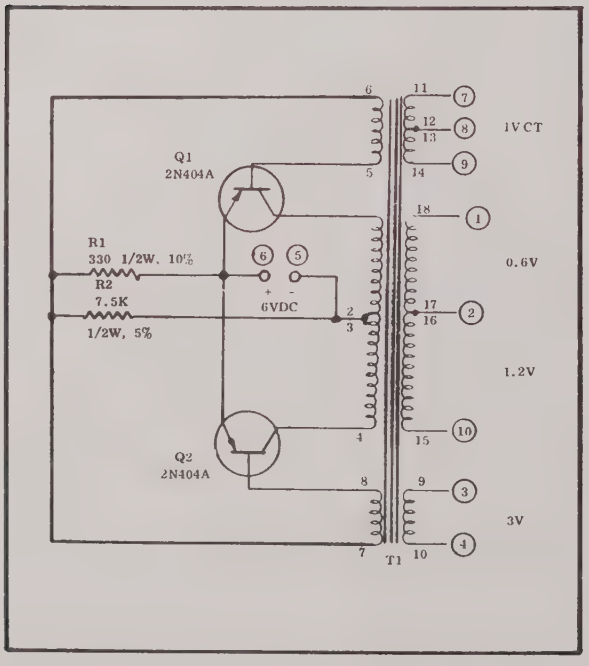


Figure 5-2. DC-AC Inverter Schematic.

5-15. Troubleshooting the Measuring Circuit (Figure 5-3)

5-16. Remove the power from the unit and check each component for shorts, open or broken resistor, using a multimeter. Once the trouble is located and corrected, the unit should be returned to BLH for recalibration, since these resistors are in the precision measuring circuit and use of different resistors may change the basic calibration.

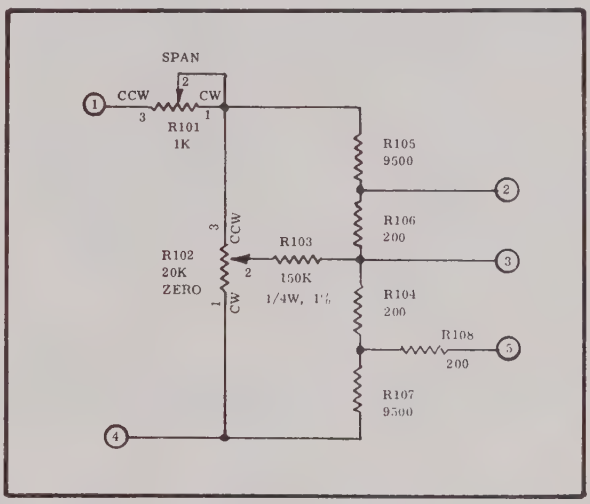


Figure 5-3. Measuring Circuit Schematic.

5-17. If the trouble cannot be found easily, return the unit to BLH for repair and recalibration.

5-18. Troubleshooting the Amplifier (Figure 5-4)

5-19. Remove the amplifier board by removing the four screws (one at each corner). Lay the amplifier on a flat, non-conductive surface. Disconnect only the input signal leads, terminals 1 and 2.

a. Connect an audio oscillator to the input terminals 1 and 2. Adjust the oscillator to provide an input signal of 1KHz at a voltage of approximately 20 microvolts.

b. With the oscilloscope in the differential mode, check each transistor stage by connecting the oscilloscope leads to each stage, collector to collector.

c. When the problem is corrected, the amplifier must be balanced as follows:

d. Short circuit the input terminals 1 and 2 with a jumper lead.

e. Connect a multimeter set at the 2.5Vdc scale across the collectors of Q2 and Q3.

f. Adjust R10 until the voltage for a reading of less than 0.05Vdc on the multimeter.

g. Remove the jumper lead at the input terminals.

5-20. CALIBRATION

5-21. Calibration of the Model 352A requires the use of an accurate mV/V signal source such as BLH Model 625 Precision Calibrator. Referring to the Model 625 Calibrator manual, proceed as follows:

a. Connect the binding posts at either side of the Model 625 to the Model 352A color-for-color.

b. Set the Model 625 bridge resistance selector switch to the side being used; 120-ohm or 360-ohm.

c. Set the Model 625 RANGE switch to the 2mV/V range.

d. Set the Model 625 STEP switch to zero.

e. Set the RANGE switch on the Model 352A to the 2mV/V range.

f. Set the POWER switch on the 352A to the CHECK position to determine if the battery voltage is at a satisfactory level, then position the POWER switch to the ON position. Allow a few minutes for the indicator to stabilize.

g. Rotate the % OUTPUT dial to 000. The null-meter pointer should indicate zero (midpoint on the meter scale).

h. If the null-meter does not read zero, remove the four screws on the front panel and carefully slide the indicator out of the case to expose the measuring circuit which is located on the left side.

i. Adjust the ZERO control, R102, with a screwdriver until the meter reads zero.

j. Set the Model 625 STEP switch to the 2mV/V position.

k. Rotate the % OUTPUT dial to the 100 percent position. The null-meter should indicate null (pointer at center of scale). If pointer is not at the scale center, adjust SPAN control, R101, until meter zeros.

l. Reset the Model 625 STEP switch to zero and recheck the zero reading on the 352A. If a zero shift has occurred, repeat steps (g) through (k) until no change occurs.

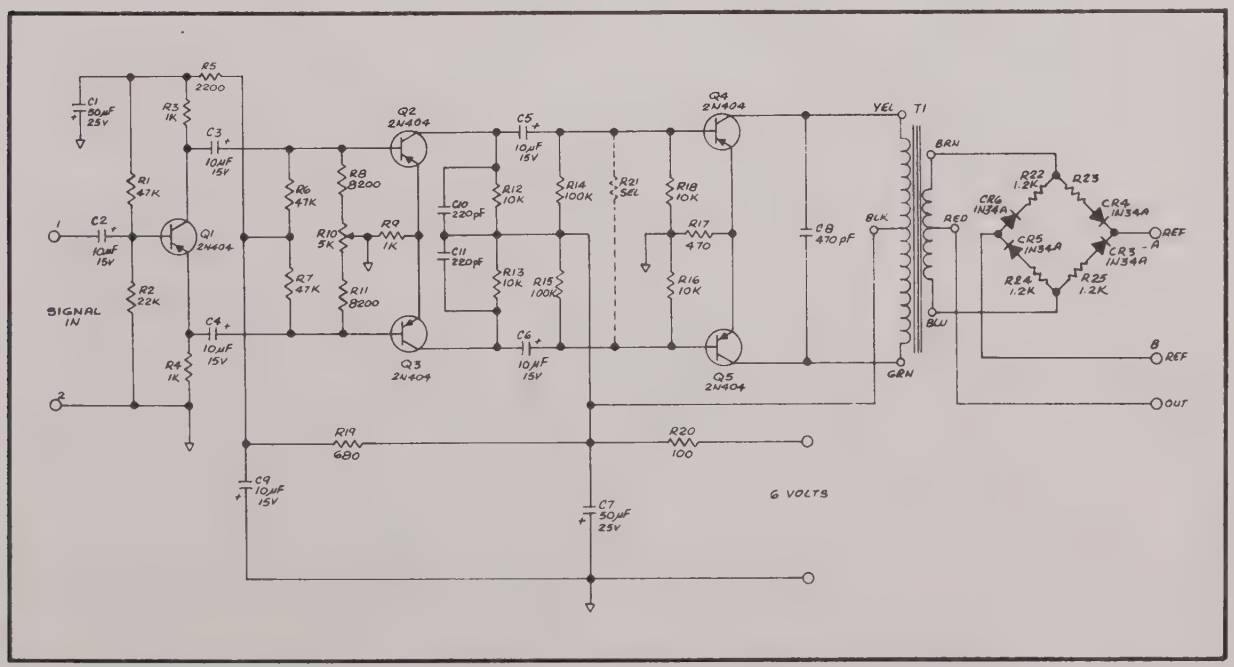


Figure 5-4. Amplifier Schematic

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for identifying and ordering replacement parts. Table 6-1 lists, in alpha-numeric order, parts by reference designator and provides the following information on each part:

a. BLH part number (where BLH is sole source).

b. Total Quantity used in the instrument (TQ column). Quantity listed where item first appears on list.

c. Recommended spares for year application in a remote location (or for 2000 hours). RS Column.

d. Typical manufacturer of the part (where applicable).

e. Manufacturer's part number.

6-3. ORDERING INFORMATION.

6-4. To obtain replacement parts, address order or inquiry for parts to the nearest BLH Sales/ Service Office or direct to BLH. Identify parts by BLH part number.

6-5. To order parts not listed in Table 6-1, provide the following:

a. Model Number of instrument.

b. Serial number of unit.

c. Description of the part including function and location.

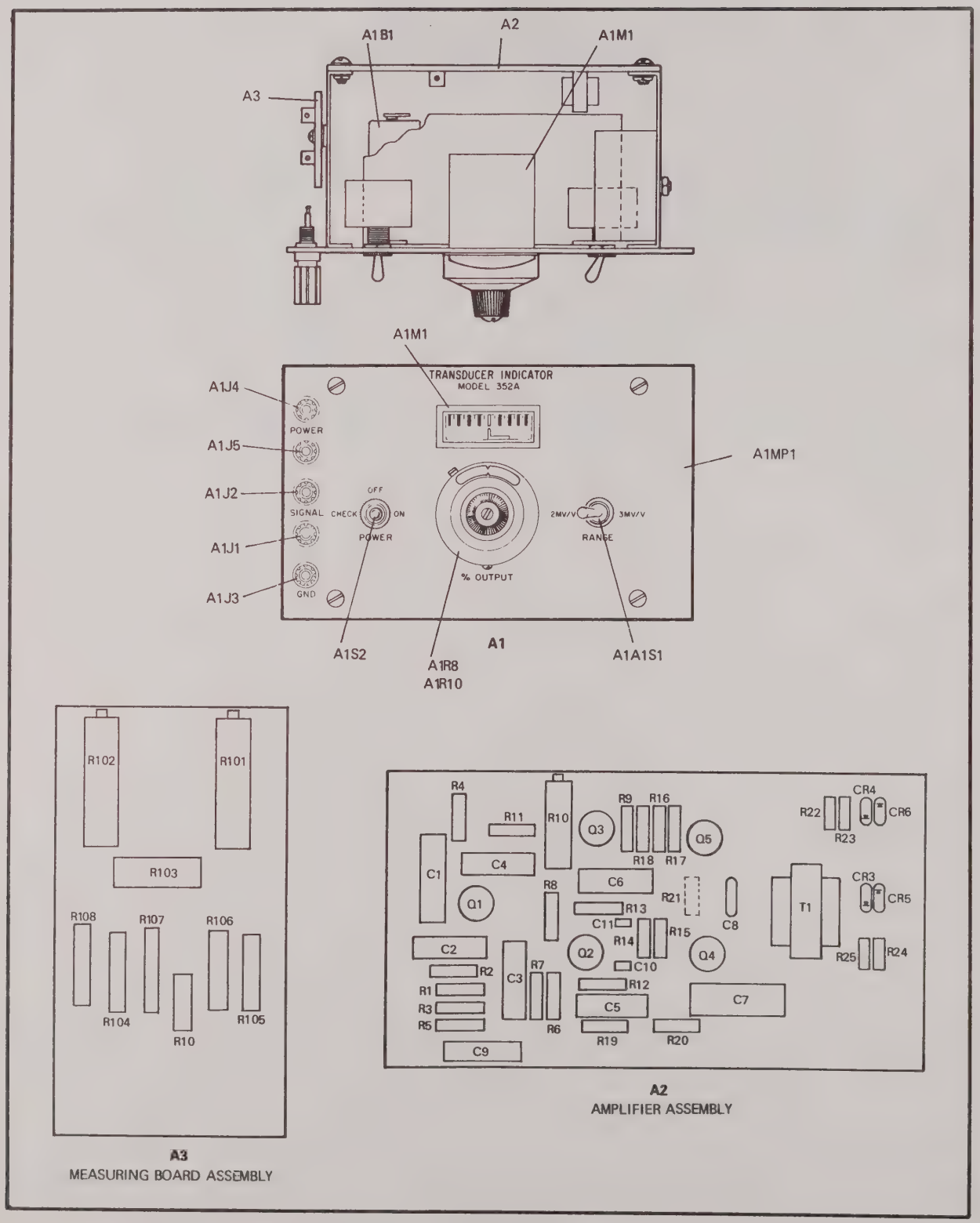


Figure 6-1. Model 352A Parts Locations

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
End Item	404189-4		1	Model 352A Transducer Indicator		
A1	403870-2		1	Assembly, Front Panel		
A2	276212-4		1	Assembly, Amplifier		
A3	275051-3		1	Assembly, Measuring Board		
B1	--------		4	Battery, 1-1/2V "C" Cells		
A1	403870-2		1	Assembly, Front Panel		
A1J1	135145-8		1	Binding Post - RED		
J2	135146-8		1	Binding Post - WHITE		
J3	135148-8		1	Binding Post - YELLOW		
J4	135149-8		1	Binding Post - BLACK		
J5	135150-8		1	Binding Post - GREEN		
A1M1	402880-1		1	Meter		
A1MP1	275011-2		1	Panel		
A1R8	135359-8		1	R: Variable, 200 ohm, 10-turn		
	135674-8		1	Dial, Counting, p/o R8		
A1R10	129905-8		1	R: Fixed, 150K, 1/2W, 5%		
A1S1	132959-8		1	Switch, 2-position, toggle		
A1S2	135469-8		1	Switch, 3-position, toggle		
A2	276212-4		1	Assembly, Amplifier		
	276385-2		1	Terminal Board		
A2C1	135381-8		2	C: 50uF, 25V		
C2	135385-8		6	C: 10uF, 15V		
C3			-	Same as C2		
C4			-	Same as C2		
C5			-	Same as C2		
C6			-	Same as C2		
C7			-	Same as C1		
C8	135386-8		1	C: 5000 pF, 500V disc		
C9			-	Same as C2		
C10	137544-8		2	C: 220pF		
C11			-	Same as C10		
A2CR1			-	Not used		
CR2			-	Not used		
CR3	412515-1		4	Semicon: Diode 1N34A		
CR4			-	Same as CR3		
CR5			-	Same as CR3		
CR6			-	Same as CR3		
A2Q1	278441-1		3	Transistor: 2N404 Matched		
Q2			-	Same as Q1		
Q3			-	Same as Q1		
Q4	279367-1		2	Transistor: 2N404 Matched pair		
Q5			-	Same as Q4		
A2R1	127238-8		3	R: Fixed 47K, 1/2W, 10%, CC		
R2	127234-8		1	R: Fixed, 22K, 1/2W, 10%, CC		
R3	127218-8		3	R: Fixed 1K, 1/2W, 10%, CC		
R4			-	Same as R3		
R5	127222-8		1	R: Fixed 2200, 1/2W, 10%, CC		
R6			-	Same as R1		
R7			-	Same as R1		
R8	127229-8		2	R: Fixed, 8200, 1/2W, 10%, CC		
R9			-	Same as R3		
R10	135384-8		1	R: Variable 5K, 1/2W, 10%, CC		
R11			-	Same as R8		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A2R12	127230-8		4	R: Fixed 10K, 1/2W, 10%, CC		
R13			-	Same as R12		
R14	127242-8		2	R: Fixed 100K, 1/2W, 10%, CC		
R15			-	Same as R14		
R16			-	Same as R12		
R17	127214-8		1	R: Fixed 470, 1/2W, 10%, CC		
R18			-	Same as R12		
R19	127216-8		1	R: Fixed 680, 1/2W, 10%, CC		
R20	127206-8		1	R: Fixed 100 ohm, 1/2W, 10%, CC		
R21			1	R: Fixed Select		
R22	127219-8		4	R: Fixed 1.2K, 1/2W, 10%, CC		
R23			-	Same as R22		
R24			-	Same as R22		
R25			-	Same as R22		
A2T1	276178-1		1	Transformer		
A3	275051-3		1	Assembly, Measuring Board		
	275047-3		1	Board, Circuit		
A3R101	135563-8		1	R: Variable, 1K		
R102	135564-8		1	R: Variable, 20K		
R103	127448-8		1	R: Fixed, 150K, 1/4W, 1%		
R104	134096-8		3	R: Fixed 200, 1/4W, 1/2%		
R105	134097-8		2	R: Fixed 9500, 1/2W, 1/2%		
R106			-	Same as R104		
R107			-	Same as R105		
R108			-	Same as R104		